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THE MANAGEMENT OF TROUT STREAMS OF THE
EAST SLOPES OF THE ROCKY MOUNTAINS IN ALBERTA.

by

M. J. Paetz

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THE UNIVERSITY OF ALBERTA

THE MANAGEMENT OF TROUT STREAMS OF THE
EAST SLOPES OF THE ROCKY MOUNTAINS IN ALBERTA.

A DISSERTATION
SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
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FACULTY OF ARTS AND SCIENCE
DEPARTMENT OF ZOOLOGY

by

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Edmonton, Alberta,
April, 1957

UNIVERSITY OF ALBERTA

School of Graduate Studies

The undersigned hereby certify that they have read and recommend to the School of Graduate Studies for acceptance, a thesis entitled "The Management of Trout Streams of the East Slopes of the Rocky Mountains in Alberta", submitted by Martin Joseph Paetz, B.Sc., in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

In 1955 and 1956 studies were made of the fish populations in limited sections of a number of trout streams on the East Slopes of the Rocky Mountains. Three creeks were selected from the Oldman River drainage where tributary streams were open and closed to fishing on alternate years. Three were selected from the Bow River drainage system where streams were open one year out of every three. However, two of the streams studied in the Bow system were changed to the open on alternate years plan during the period of study.

Five streams were sampled twice and one was sampled only once. The standing population at time of sampling was calculated for each study section. Growth rate of trout and age at maturity were studied. The data indicate that fishing is selective for the larger trout of each age group and that the fishery is dependent mainly on fish of ages two and three years. By the end of an open season anglers are also selecting from fish of the age one group. There is a suggestion that the brood stock is adversely affected in heavily fished portions of the streams.

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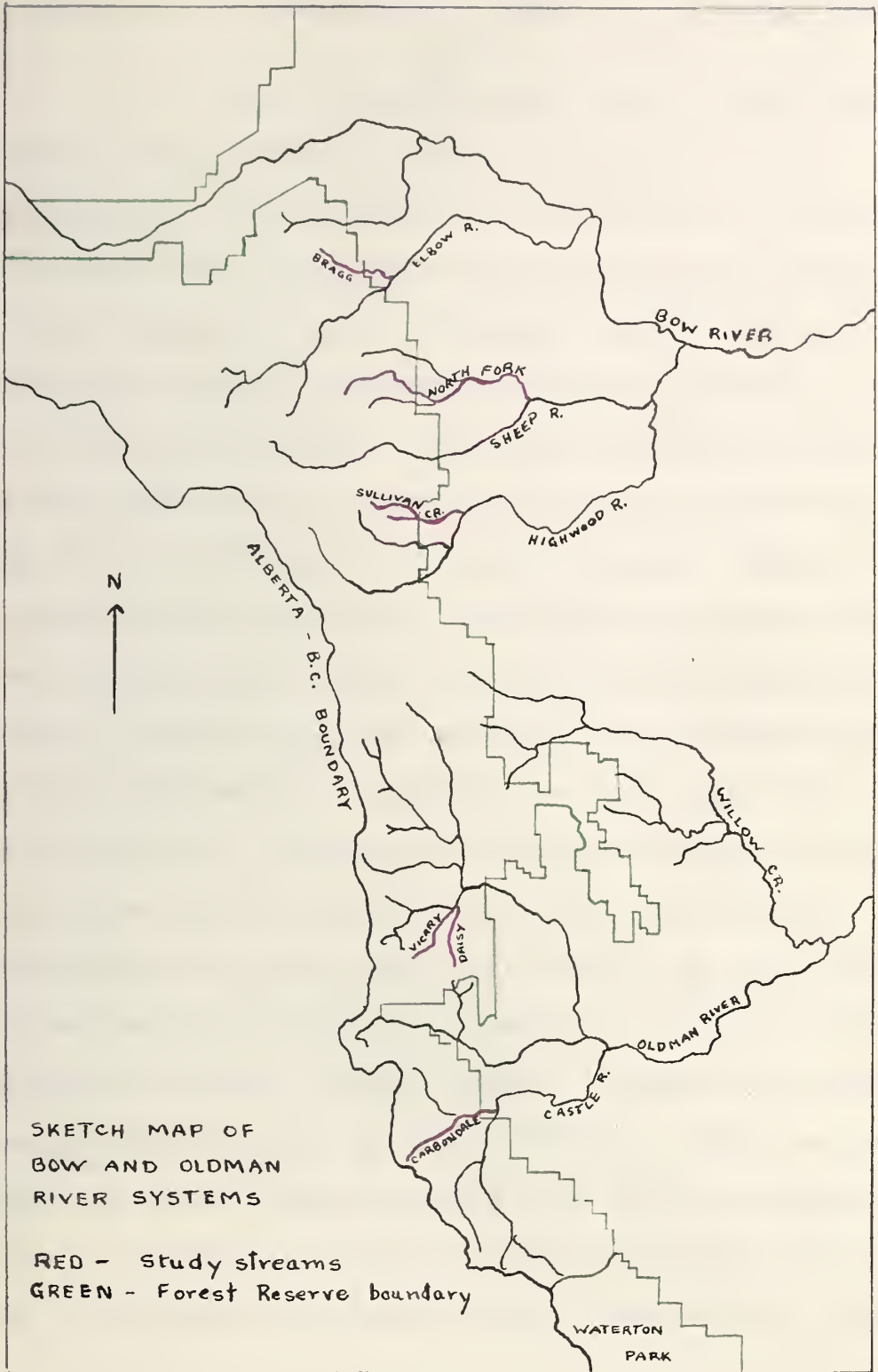
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REVIEW OF THE LITERATURE ON TROUT STREAM MANAGEMENT

Over the past twenty years a great many authors have written on trout management on this continent. From the work of these writers it may be concluded that throughout the various states and provinces there has been considerable uniformity in the history of trout management practices. Briefly, this history is as follows. Increasing human populations brought about heavier fishing pressure; a measurable decline in the quality of angling ensued. Natural reproduction was generally looked upon as a wasteful and very inefficient method of providing an adequate supply of fish. To the early fish culturist, the remedy appeared to be the construction of hatcheries where eggs were stripped from wild fish, incubated in hatchery troughs and the fry, when able to feed, were released in streams. This practice was general until the 1920's; at this time, as there was no apparent improvement in angling, workers began to question its efficiency. Pioneer investigations were carried out by Dr. R. E. Foerster (1936) on the efficiency of salmon hatcheries in British Columbia. Over a period of ten years it was shown that there was no significant difference between the numbers of downstream

migrant young salmon when natural reproduction had taken place and when hatchery methods had been employed in place of natural reproduction. Foerster's work also revealed that natural fertilization in salmon was highly efficient and that the mortality took place after hatching. Subsequent investigations showed that these facts were also true for trout (Schneberger, 1948).

It was then theorized that losses from environmental factors would not be as great among fingerlings as among fry so that fry plants were more or less abandoned in favor of rearing trout to fingerling size. Smith and Moyle (1944) report that planting of fingerlings in Michigan was begun in 1919. The practice became widely known in North America over the next fifteen years. It may be emphasized that the aim of this policy of planting fingerling trout was to increase fish production in natural waters where spawning stocks of various species already existed. By the late thirties and early forties a good deal of research was being conducted on the survival to the creel of fingerling planted trout. Some of the results are as follows.

Hazzard and Westerman (1945) summarized the Michigan experiments with fingerling trout:

<u>Species</u>	<u>No. of Experiments</u>	<u>Percentage Return</u>
Brook trout	19	1.16
Rainbow trout	12	2.2
Brown trout	5	3.4

Surber (1940) in Virginia reported a survival to the creel of 2.4 percent of mixed plantings of fingerling rainbow and brook trout. Schuck and Kingsbury (1941) in New York, reported a survival over one year of 6.3 percent of brown trout fingerlings. Chamberlain (1943) reported a recovery of 0.7 percent of three-inch fingerlings (all species) in the streams of the Pisgah National Forest. Recoveries by anglers of planted fingerling trout in other States as reported by Cooper (1954) are:

North Carolina	brook trout	1.4 percent
"	"	brown trout 10.6 "
"	"	rainbow trout 2.4 "
Vermont	brook trout	1.1 "

These figures represent the returns from the planting of many thousands of fingerling hatchery trout of various species in good trout waters and are abundant proof that planting such trout did not produce the desired results. Schuck (1948) pointed out further that the poor returns were due to lack of survival of

the hatchery product rather than to ineffective angling removals and that the survival was much lower than survival of wild fish of comparable ages.

As a result of these findings hatchery practice was changed to the production of legal-sized fish for stream planting. Anglers were generally of the opinion that plants of legal-sized trout should take place in the fall so that these fish might grow over winter and become more like the resident trout in sporting quality. Fall stocking of legal trout became extensive but again the fishing showed little or no improvement. Fishery workers investigated this type of stocking in practically all states in which it was being used and showed that a very small percentage of fall planted legal trout survived to be caught by anglers in the following season. However, spring planted and during-the-fishing-season-plants of 'keeper' trout showed considerably better returns to the angler. The relative merits of fall planting and during-the-season planting received much attention and have been adequately covered in the literature.

Miller (1949) summarized the available data from ten states including the findings of fourteen workers. He pointed out that returns of spring planted legal-sized fish vary from 5 to 50 percent (as high as

82 percent in rare cases) and average about 30 percent. Returns from fall planted legal-sized fish seldom exceed 5 percent. The evidence was overwhelmingly in favor of spring and open season stocking. However the higher returns from these plants may only be expected where fishing pressure is heavy so that the hatchery trout are recovered within four to six weeks after release. Hale (1952) in Minnesota found that 79 percent of open-season-planted legal-sized fish were caught in a stream where fishing was heavy as compared with returns of 43.5 percent and 19.6 percent in streams with lighter fishing intensity. In a further study Hale (1954) concludes that planted legal brook trout play a role in areas of low natural reproduction and heavy fishing pressure.

Smith and Smith (1944), also in Minnesota, report that 78.1 percent of legal hatchery trout were taken during the first four weeks of the fishing season and that their contribution the following year was negligible.

Trembley (1945) in Pennsylvania found that 76 percent of returns of planted trout were made the first day of the season. Only 1.7 percent were taken during the following season.

Cooper (1953) in Michigan obtained returns of 90 percent of brook trout, 74 percent of brown trout and 79 percent of rainbow trout within the first 40 days after planting. Recoveries in the next season varied from zero to 2.3 percent of entire planting.

The relatively high percentage of returns from spring and summer planting of legal-sized trout led to widespread adoption of this policy in most states and this continues to play an important role in their fish management at the present time. However, it has been shown by Smith and Smith (1944) in Minnesota, by Shetter (1944) in Michigan and by Hale (1952) in Minnesota that wild trout still provide from 55 to 89 percent of the total catch in areas where legal-sized hatchery trout are stocked.

It is now generally accepted that artificial stocking with legal-sized trout is justified where there exists a fishing load requiring more fish than the natural productive capacity of the stream will furnish.

TROUT MANAGEMENT IN ALBERTA

Alberta has somewhat over 4000 miles of natural trout streams (excluding National Parks) on the east slopes of the Rocky Mountains. These streams are components of four main drainages, namely, the South Saskatchewan (including Oldman and Bow drainages), the North Saskatchewan, the Athabasca, and the Peace River systems. The North and South Saskatchewan Rivers eventually contribute their waters to the Hudson Bay while the Athabasca and Peace systems drain into the Arctic Ocean via the Mackenzie River. The tributaries of the Peace River in Alberta have been little studied and owing to their inaccessibility make an insignificant contribution to our stream sport fishery. Many streams in the Athabasca drainage are in the same category but the McLeod and Pembina watersheds for some time have provided chiefly rainbow trout, Salmo gairdneri (Richardson) and Arctic grayling, Thymallus arcticus signifer (Richardson) for central and northern Alberta anglers. The waters of the North and South Saskatchewan systems, particularly the Red Deer, the Bow and Oldman drainages, support the bulk of Alberta's angling. The introduced brook trout, Salvelinus fontinalis (Mitchill) and brown trout, Salmo

trutta Linnaeus, and to a lesser extent the native Dolly Varden, Salvelinus alpinus malma (Walbaum), and Rocky Mountain whitefish, Coregonus williamsoni Girard, are the species taken in the North Saskatchewan system. Native cutthroat, Salmo clarki (Richardson), supplemented possibly by rainbow-cutthroat hybrids, S. gairdneri x S. clarki, are the dominant sport fish of the Bow and Oldman systems. Attempts to establish rainbow trout by persistent heavy plantings in the tributaries of the latter rivers have been largely unsuccessful and of questionable value.

In the present study the fish concerned is mainly the cutthroat trout. It is known that some hybridization with the introduced rainbow has taken place. In using the term 'cutthroat trout' it is recognized that some of these hybrids may be included.

Prior to 1950, the Alberta trout management policies consisted of:

- (a) Planting of hatchery fish from fingerling to yearling size in so-called 'fished-out' streams.
- (b) Closure of tributary streams, in the belief trout from the rivers move up the tributaries to spawn and hence these tributaries keep the larger streams 'stocked' with trout.
- (c) Closed seasons to protect trout during spawning time.

- (d) Enforcement of a minimum size for 'keeper' trout, designed to allow fish to spawn at least once before capture.

Preliminary surveys of many of Alberta trout streams pointed out the fallacies of existing policies regarding legal size limits, feeder stream theories and closed seasons (Miller, 1952). Research into the survival of hatchery trout in streams containing resident wild trout populations (Miller, 1955), also showed the misuse of our hatchery trout. As a result of these findings, trout management underwent drastic changes in this province. Legal size limits on trout, the feeder stream theory and planting of hatchery trout in streams with existing wild populations, were discontinued. In 1952 a new management plan for East Slope trout streams was substituted for the traditional policies which had been in force.

The new plan was first adopted on a trial basis on the South Saskatchewan watershed. It called for continuously open seasons on the larger rivers and a fallow system of managing the tributaries. In the Oldman river drainage where trout growth was found to be generally good, the fallow system provided for closing and opening the tributaries to fishing on alternate years while Bow river tributaries, due to slower growth rate^{of trout,} were open

one year in three.

In 1955 prior to a definite evaluation of the management system, the Elbow river tributaries (Bow drainage) were changed to the one year closure plan similar to the Oldman tributaries. In 1955, the alternate open and closure policy was extended to the tributaries of the North Saskatchewan drainage.

The purpose of this investigation was to determine standing crops of trout and the population structure in streams on which this management policy has been operating; and to assess the effect of the two types of fallow management on the trout populations.

DESCRIPTION OF STUDY STREAMS

The streams chosen for population studies were: A. Daisy Creek and Vicary Creek of the Oldman River drainage, considered typical of the small streams under alternate open and closure; the Carbondale River as an example of a larger stream under the same plan. B. Sullivan Creek, representative of streams managed on the two year closure - one year open plan. C. Bragg Creek and North Fork Sheep as examples of streams changed from a two year closure - one year open plan, to ^{being} open alternate years.



Photo. 1. Typical section of lower Daisy Creek (June).

A. Open Alternate Years

Daisy Creek

This small stream has its source at an altitude of 5400 feet, some ten miles north of the town of Frank. It courses almost due north for approximately nine water miles to join Racehorse Creek at an altitude of 4700 feet. The drop is mainly in a series of small falls between which are pools and briskly flowing riffle stretches. The midstream velocity in a typical riffle varies from 2.8 feet per second in June to 1.3 feet per second in September. The volume of flow in these months varies from 36.8 to 12.7 cubic feet per second respectively. The Livingstone range, rising to an altitude of 8000 feet, parallels the stream on the east while partially forested ridges approximately 6500 feet in altitude, lie to the west of the stream.

Miller (1950) describes the stream as having abundant bank cover (Photo 1) and a moderate food supply. Pools are generally of good quality. In the lower reaches, a 1000 yard section was found to contain 36 pools from $2\frac{1}{2}$ to $5\frac{1}{2}$ feet in depth. The resident fish are predominantly cutthroat trout, although a few Dolly Varden and Rocky Mountain whitefish inhabit the lower portions. The whitefish are believed to be seasonal



Photo. 2. Lower Vicary Creek. (Note shale bank on left.)



Photo. 3. Vicary Creek. (Note change in bank cover.)

migrants from Racehorse Creek. Daisy Creek may be rated as a better than average Alberta East Slope trout stream.

Vicary Creek.

This creek rises at an altitude of 5600 feet and follows a course roughly parallel to that of Daisy Creek. Its confluence with Racehorse at an altitude of 4800 feet is located about one mile upstream from the mouth of Daisy Creek. Over the 12 water miles of its length, this stream has an average gradient of 67 feet per mile. The watershed is principally foothill type country supporting mixed coniferous growth. This forest is discontinuous, being replaced frequently by open grassy slopes and bare shale outcrops. Stream bank cover consists mainly of willow and other low shrubs and is sparse to moderate in supply (Photos 2 and 3). In the lower reaches the stream averages about 25 feet in width during late June and about two-thirds of this width in mid September. Midstream velocity in late June was 1.9 feet per second and the volume of flow was calculated to be 66.2 cubic feet per second. No flow data were secured in the fall, but observations show that this stream has a wide variation between maximum and minimum flow volumes. In September, 1956, the volume of flow was estimated to be less than eight

cubic feet per second. The daily summer temperature range of Vicary Creek is from 45° to 55° F. Miller's observations (1949) on food supply indicate quantities grading from poor to moderate. Cutthroat trout appear to be the only resident fish although Rocky Mountain whitefish do occur seasonally in the lower reaches.

Carbondale River.

This stream is the largest included in the present investigation. It rises at an altitude of 6000 feet in the vicinity of the North Kootenay Pass and descends at an average gradient of slightly over a hundred feet per mile. It is one of the main components of the Castle River drainage system. The drainage area varies from mountainous terrain to forested ridges. Fires and extensive logging operations have denuded much of the coniferous forest stand in the upper parts of the Carbondale valley. Evidence of this^{is} in the form of log jams and trash piles^{that} clog the river channel in the vicinity of Lost and Gardiner Creeks. The stream averages about twenty-five feet in width at Lost Creek and about forty feet in width near its mouth. In late June the midstream velocity was 3.3 feet per second and the volume of flow was calculated to be 103 cubic feet per second. Seasonal fluctuation is very pronounced;

the estimated volume of flow in September was less than twenty cubic feet per second. The middle and lower reaches of this stream contain many fine deep pools shaded by rocky projections of the banks. Vegetative bank cover, however, is generally lacking. The food supply lies within the medium range and is comparable to that of other streams in the Castle system. Cutthroat trout and Dolly Varden are found throughout the stream. Longnose suckers, Catostomus catostomus (Forster), and Rocky Mountain whitefish are resident in the lower portions.

B. Open One Year in Every Three

Sullivan Creek.

This creek rises on the west slopes of Blue Ridge Mountain and descends at an average gradient of 70 feet per mile to enter the Highwood River west of the village of Longview. It comprises about ten and one-half miles of trout water. The stream's course is through rolling foothills which support a varied vegetative cover of grass and mixed aspen and conifer stands. For most of its length the stream is more gentle than the gradient suggests. Shaded pools are frequent and an adequate bank cover of willow and alder is present. In

the upper reaches Sullivan Creek is three to six feet wide. This gradually increases to widths of 15 to 25 feet near its mouth. There is less evidence of prolonged turbidity and flooding than on many East Slope trout streams. The volume of flow on October 16, 1956 was found to be six cubic feet per second and a midstream velocity of 1.8 feet per second was recorded in a narrow riffle section. The fish population consists primarily of cutthroat trout. Dolly Varden are present though not numerous and Rocky Mountain whitefish, longnose dace, Rhinichthys cataractae (Valenciennes), and white suckers, Catostomus commersoni (Lacépède), occur in the lower reaches.

C. Changes from One Open Year in Three to Alternate Years
Bragg Creek.

Rising at an altitude of 5200 feet on the north-east slopes of Moose Mountain, Bragg Creek flows in an easterly direction to join the Elbow River at the settlement of Bragg Creek. It descends approximately nine hundred feet in a 12 mile course giving an average gradient of 75 feet per mile. Most of the descent occurs in the first five miles so that the lower seven miles, with an average gradient of 25 feet per mile, is a gentle meandering type of stream. The watershed is typical

foothill country supporting mixed deciduous and coniferous forest. In some regions the valley widens into meadows in which willows and sedges are dominant vegetative types. The willows provide a generous bank cover and an adequate amount of shade. The stream bottom varies from rubble in the riffles to silt in many of the pools. Silting appears to be the result of former beaver activity on the stream and erosion of the sod banks during high water. In its lower six miles, Bragg Creek averages 15 feet in width and has a midstream velocity of 0.78 feet per second during August. The volume of flow in late summer is 4.8 cubic feet per second. Maximum stream temperatures in August reach 60°F. The bottom fauna grades from poor in lower reaches (Miller, 1950) to medium in middle sections according to recent observations. Cutthroat trout, Rocky Mountain whitefish, Dolly Varden, eastern brook trout, longnose dace and white suckers inhabit lower Bragg Creek. Cutthroat trout are the most abundant game fish. Three to four miles upstream, the fish fauna shifts to a predominance of brook trout.

North Fork Sheep.

The north fork of the Sheep River rises at an altitude of 6000 feet on the north-east slopes of Three Point Mountain and descends for 37.5 water miles to enter the South Sheep at an elevation of 3700 feet.



Photo. 4. Typical section of North Fork Sheep below Forest Reserve boundary.

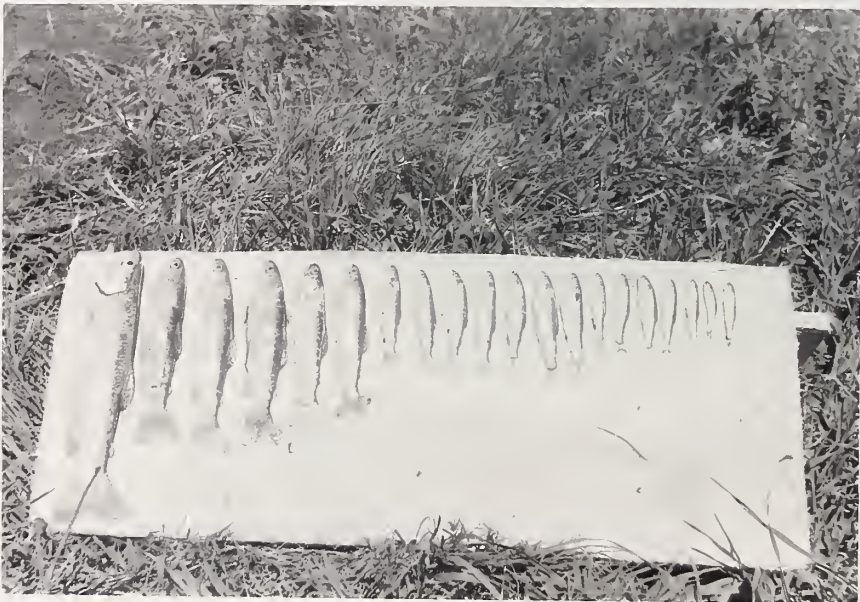


Photo. 5. Samples of cutthroat trout from North Fork Sheep, June, 1955.

The average gradient is 98 feet per mile with a good deal of the drop occurring in the first 10 to 12 miles. The lower two-thirds of the stream have a more gentle gradient of about 30 feet per mile. In the Forest Reserve the watershed consists primarily of hills and high ridges supporting mixed deciduous and pine-spruce stands. The lower parts of the stream wind through relatively open agricultural lands. Bank cover is generally lacking (Photo 4) except along a few miles of stream below Threepoint Canyon. Long shallow riffles and occasional deep pools are characteristic of the stream throughout most of its length. The width varies from 20 to 50 feet and averages about thirty-three feet during July. The calculated volume of flow on July 24, 1956, was 50 cubic feet per second and the estimated volume of flow was ten cubic feet per second in September of the same year. In winters following particularly dry summers, the flow has been known to cease entirely. The bottom fauna is rated as poor in quantity (Miller, 1950), probably a result of wide variations in level. Summer temperatures range between 50° and 70°F. Cutthroat trout are the main game fish in that part of the stream within the Forest Reserve (Photos 5 and 6). From the reserve boundary to the hamlet of Millarville, cutthroat trout,



Photo. 6. Cutthroat trout and Rocky Mountain whitefish from North Fork Sheep, July, 1956.



Photo. 7. Emulsion of Fish-Tox and water shortly after application in Bragg Creek.

Dolly Varden, eastern brook trout, Rocky Mountain whitefish, Jordan's sucker/, Pantosteus jordani (Evermann), and longnose dace occur in the stream. In the lower reaches, as the water becomes murky and considerably warmer, cyprinids and ^{other} coarse fish predominate although some trout and larger numbers of Rocky Mountain whitefish are present. Brown trout have been recently introduced into lower North Fork Sheep but the success of these introductions is not known.

METHODS

In each of the test streams, study areas were selected which were 250 to 300 yards long. Complete population estimates were carried out in these sections so that trout populations after a period of closure could be compared to populations in the same stream after an open season. Three-eighths inch mesh seines were used to form a fish-tight fence across the stream at the lower end of each test section. The commercial rotenone preparations, Fish Tox or Noxfish (Photo 7) were used to kill all fish in the sections. These preparations were mixed with appropriate portions of water and the resulting emulsion was poured slowly into the stream at



Photo. 8. Dead fish which were removed from section I in Bragg Creek after poisoning.

the upper limit of the test section. The toxicant was added in small portions with 10 to 15 minute time lapses between applications until fish showed signs of distress. When distress was noted, addition of toxicant was stopped. Dead fish washed downstream and collected against the seines where they were removed during and at the end of the sampling period (Photo 8). The sections were patrolled carefully for several hours after the last application of toxicant and fish which settled to the bottom of pools and backwaters were collected with long-handled dip nets. It is believed that virtually all fish one year of age or older were recovered. However, the recovery of fish-of-the-year during fall sampling was not complete; this was due to these small fish lodging under boulders and in crevices between stones where they could not readily be seen. While carrying out the studies on Sullivan Creek a particular effort was made to recover all fish of the year since this stream has a comparatively smooth bottom in the areas sampled. It is therefore believed that the percentage of recovered fish of the year in Sullivan Creek was high.

The method of sampling used in this investigation necessitated the use of different sections of a stream each time a population census was carried out. The sections of each stream were therefore selected for their similarity with regard to number of pools,

width of stream and presence of cover. In order to prevent the killing of fish below the study area, sections were usually chosen near the confluence of another stream so that the increased volume of water would dilute the chemicals below toxic concentration. In 1956 it was possible to carry out sampling in areas where no dilution occurred, using potassium permanganate to oxidize the toxicant and render it harmless below the test section.

The fish recovered from the section were measured to the nearest millimeter (fork length), and weighed on a spring balance to the nearest quarter ounce (except fish of the year, which were lumped for weighing). Scales for age determination were taken from the left side of the fish between the dorsal fin and lateral line. The sex of sample lots of fish longer than four inches was recorded as was also the condition of the gonads.

Scale samples were mounted in a dry state between two microslides and the ages were determined with the aid of a binocular microscope which provided a magnification of 64 diameters.

Determination of age by the scale reading method was complicated by the fact that fish hatched

from late spawned eggs had not formed scales by the end of their first summer, or, when scale formation had taken place, it had frequently begun so late that the first annulus was either non-existent or very difficult to decipher.

The volume of flow of study streams was determined by the method described by Robbins and Crawford, (1954).

ANALYSIS OF SAMPLES FROM ALTERNATE YEAR TEST STREAMS (GROUP A)

Fall samples were taken in 1955 and 1956 on Daisy Creek, in the spring and fall in 1956 on Vicary Creek and only in the fall of 1956 on the Carbondale River.

Daisy Creek

Fish population studies were carried out in a section of Daisy Creek on September 9, 1955 and in a separate section on September 8, 1956. These test sections will be referred to as Section I and Section II respectively. Daisy Creek was closed to angling in 1955 and open in 1956.

Section I.

This section consisted of 300 yards of stream with a surface area of 0.43 acres. The total recovery of fish from the section, by species, was five Dolly Varden and 149 cutthroat trout. Total weight of these fish was 123.5 ounces. The calculated standing crop of trout in Section I was 17.9 pounds per acre.

Section II.

This section consisted of 250 yards of stream approximately 35 yards upstream from the upper limit of Section I. The area of the section was 0.36 acres. Recovery of fish from the section was 127 cutthroat trout with a total weight of 61.6 ounces. The standing crop of trout in section II was calculated to be 10.72 pounds per acre. Detailed analysis of these samples is shown in Table I.

The data in Table I show that although the calculated numbers of fish per acre in the two sections are similar, there is considerable variation in the number of pounds of fish per acre. Thus the standing crop in Section II is slightly less than 60% of that of Section I. This appears to be due to removal of the 10 inch or longer group of trout as well as removal of

Fig. 1. Length frequency distribution of cutthroat trout in Daisy Creek. Fig. 1a Sept., 1955; Fig. 1b Sept., 1956.

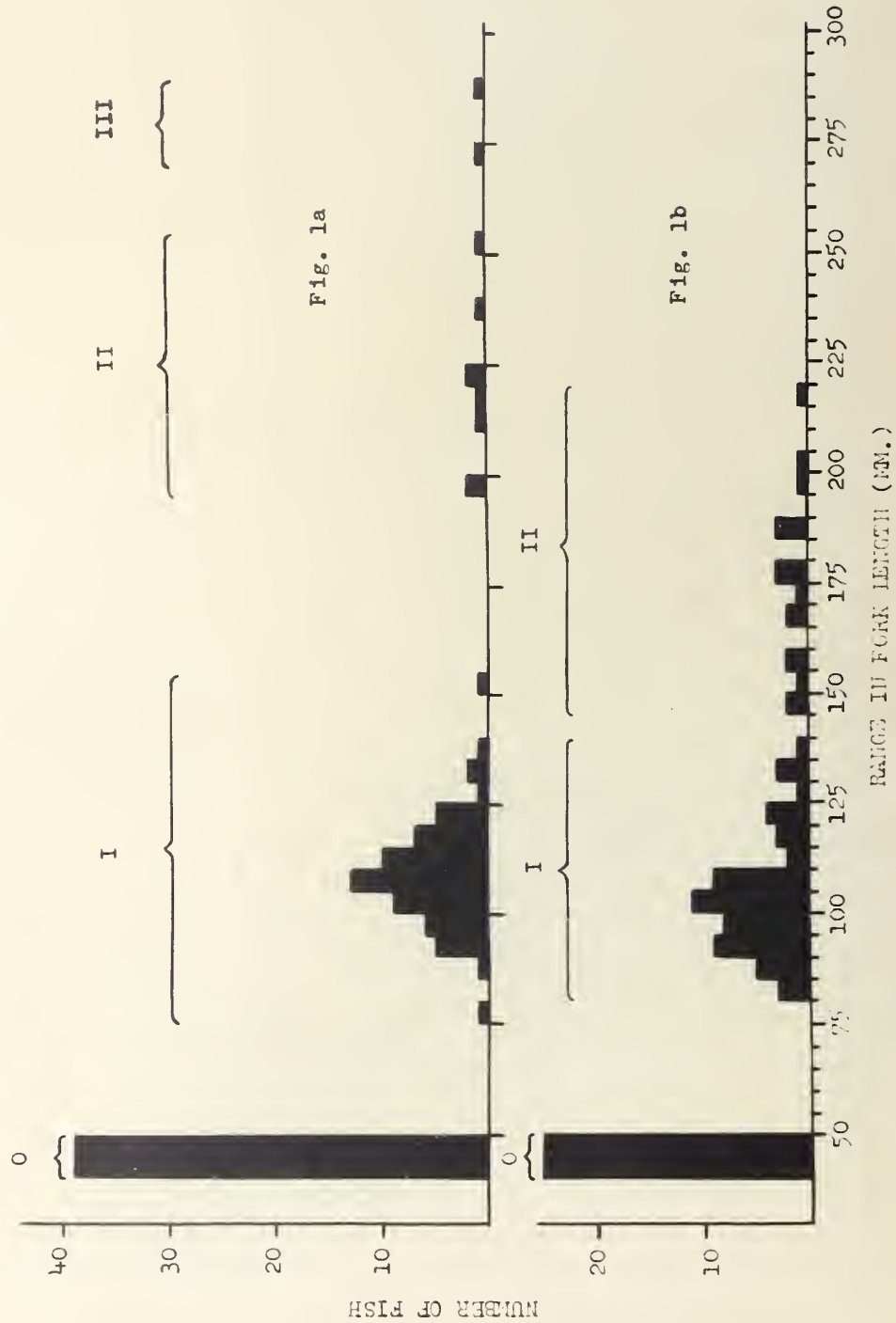
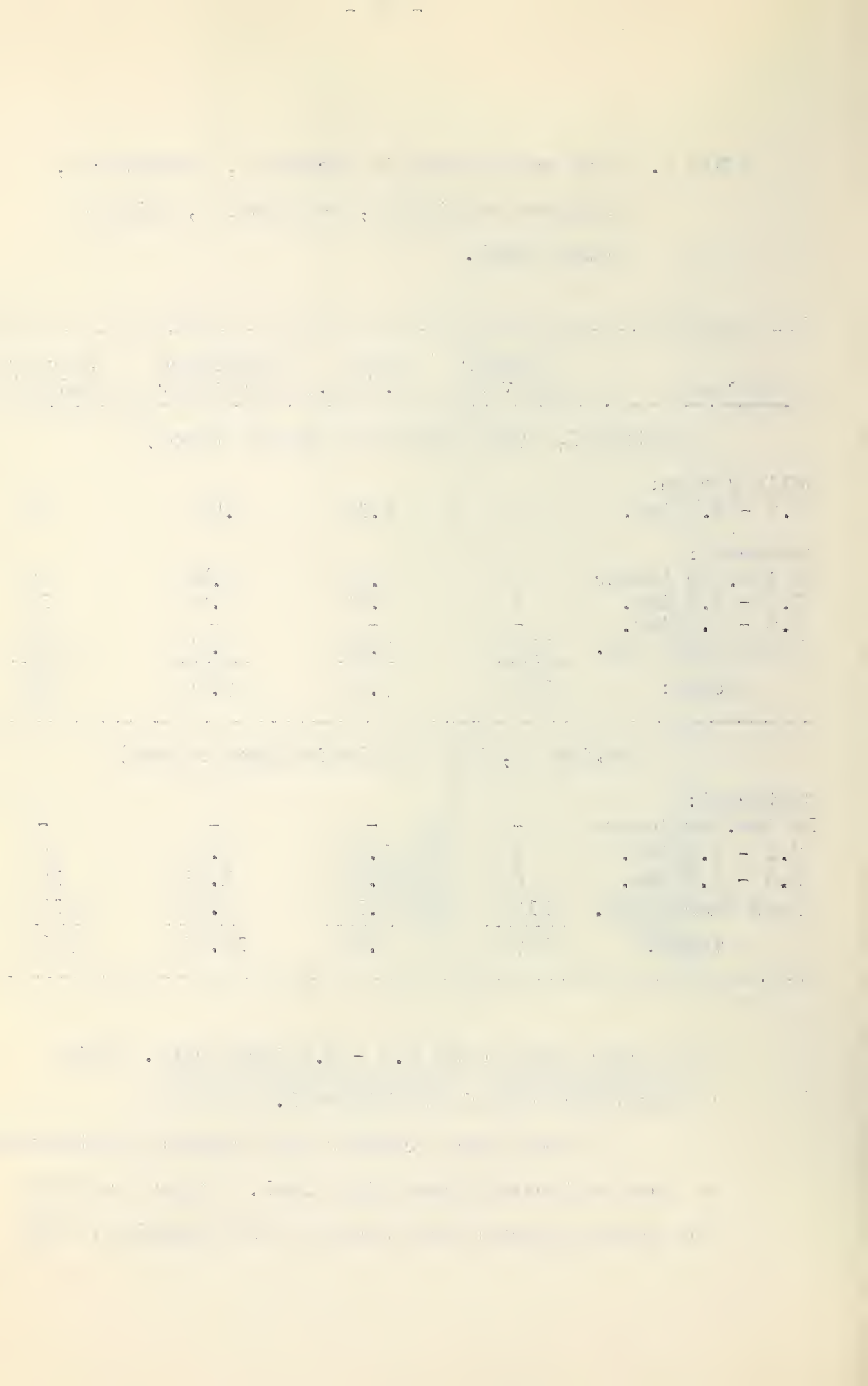


Table I. Fish populations in Section I, September 9, 1955, and Section II, September 8, 1956, of Daisy Creek.

Species	Number Recovered	Total Wt. (lbs.)	Calculated pounds/acre	Calculated number/acre
Section I, 1955 (following closed season)				
Dolly Varden:				
7.7 - 9.4 ins.	5	1.18	2.70	12
Cutthroat:				
10 ins. or longer	3	1.9	4.42	7
7.0 - 9.9 ins.	7	2.02	4.70	16
6.0 - 6.9 ins.	-	-	-	-
less than 6 ins.	<u>139</u>	<u>2.61</u>	<u>6.07</u>	<u>323</u>
Total:	154	7.71	17.89	358
Section II, 1956 (following open season)				
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	9	1.08	3.0	25
6.0 - 6.9 ins.	6	0.66	1.83	17
less than 6 ins.	<u>112</u>	<u>2.11</u>	<u>5.89</u>	<u>311</u>
Total:	127	3.85	10.72	353

the larger fish in the 7.0 - 9.9 inch group. This is shown more clearly in Figure 1.

The figure presents two frequency distributions of trout collected from Daisy Creek. Figure 1a shows the trout collected from Section I in September, 1955



and Fig. 1b those taken from Section II in September, 1956. The two sections are believed to be comparable and would be expected to yield the same numbers of trout. However, a close study of the frequencies shows that the two sections did not yield the same size frequencies of trout. A statistical comparison (Chi square test) of the two frequency distributions also reveals that they are significantly different.

The differences in the two distributions are of both age and size. The age groups involved are indicated by the horizontal brackets on the figure. It is clear that the 1956 trout were both smaller and younger; there are no age III fish, the age II fish are smaller, and the age I distribution is skewed so that the larger fish of the age group are missing. These differences may be easily accounted for by the angling pressure. No fishing was permitted in 1955; fishing was permitted in 1956. Angling is selective for the larger fish of each age group. It seems reasonable to conclude, therefore, that anglers removed all, or nearly all the III year fish, all the II year fish over 220 mm. fork length, and about half the larger I year fish.

Vicary Creek

The fish populations were studied in two sections of Vicary Creek in 1956. The population was determined in Section I on June 26 and in Section II on September 7. This stream was open to angling in 1956 after a year of closure. Section I might be considered as representative of the population when the year's angling pressure was beginning and Section II representative of the population after angling had decreased to only occasional visits.

Section I.

This section comprised 300 yards of stream located just upstream from the confluence of Vicary and Racehorse creeks. The calculated area of the section was 0.37 acres. Total recovery of fish from the section was 75 cutthroat trout and 14 Rocky Mountain whitefish with a total weight of 111.25 ounces. The calculated standing crop of fish in Section I was 18.8 pounds per acre. Rocky Mountain whitefish are probably only seasonal visitors to the lower reaches of Vicary Creek since none was recovered in the September samples upstream from Section I. For this reason it is felt that only the standing crop of trout, amounting to 10.2 pounds per acre, should be

considered from the standpoint of game fish in this stream.

Section II.

Section II was a 300 yard section located 50 yards upstream from the upper limit of Section I. The area of this section (determined in June) was 0.37 acres. Forty cutthroat trout were recovered with a total weight of 45.6 ounces. The standing crop of trout in Section II was calculated to be 7.7 pounds per acre. Further analysis of the fish population is presented in Table II.

Table II compares fish numbers and fish yields in sections of Vicary Creek which had been subject to fishing pressure for different lengths of time during the same year. Section I represents only a short exposure to fishing since high turbid water from April to early June and restricted access due to road conditions result in a limited number of fishing trips. Section II was exposed to an additional 9 to 10 weeks of fishing during a period when both road and water conditions are more or less ideal. It is noted that the standing crop of 7.0 to 9.9 inch fish in Section II is less than one-third that in Section I. Absence of trout in the 6.0 to 6.9 inch

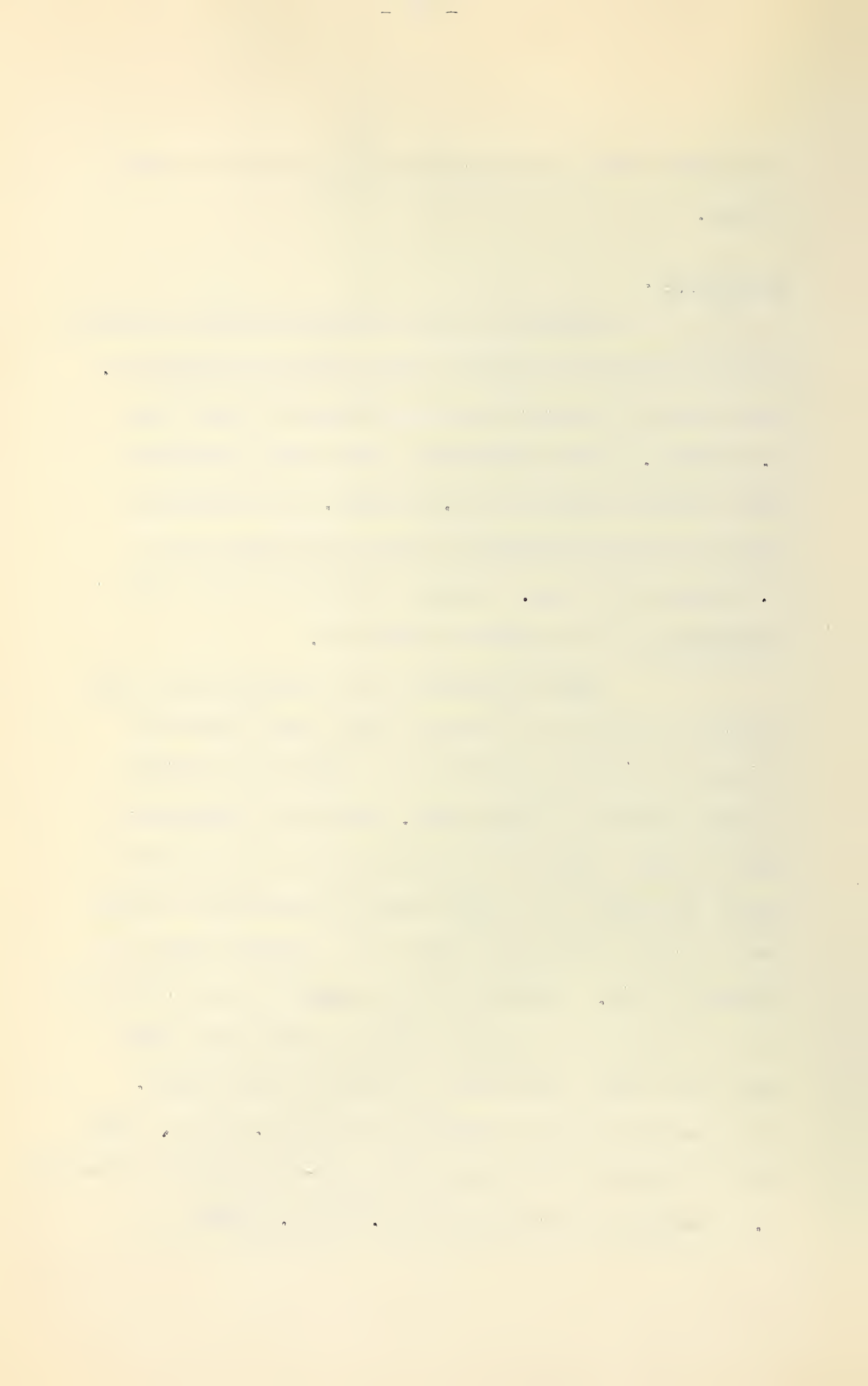


Table II. Fish populations in Sections I and II of Vicary Creek on June 26, 1956 and September 7, 1956.

Species and size range	Number Recovered	Total Wt. (lbs.)	Calculated pounds/acre	Calculated number/acre
Section I, June, 1956.				
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	6	1.52	4.1	16
6.0 - 6.9 ins.	-	-	-	-
less than 6 ins.	<u>69</u>	<u>2.27</u>	<u>6.1</u>	<u>186</u>
Total:	75	3.79	10.2	202
Section II, September, 1956.				
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	3	0.5	1.3	8
6.0 - 6.9 ins.	15	1.47	4.0	40
less than 6 ins.	<u>22</u>	<u>0.88</u>	<u>2.4</u>	<u>59</u>
Total:	40	2.85	7.7	107

group in Section I is difficult to explain. The very low numbers of fish less than 6 inches in length in both sections and particularly in Section II seems attributable to lack of brood stock in the stream, i.e., most of the females are removed before they reach spawning age.

Fig. 2. Length frequency distribution of cutthroat trout in Vicary Creek. Fig. 2a June, 1956; Fig. 2b September, 1956.

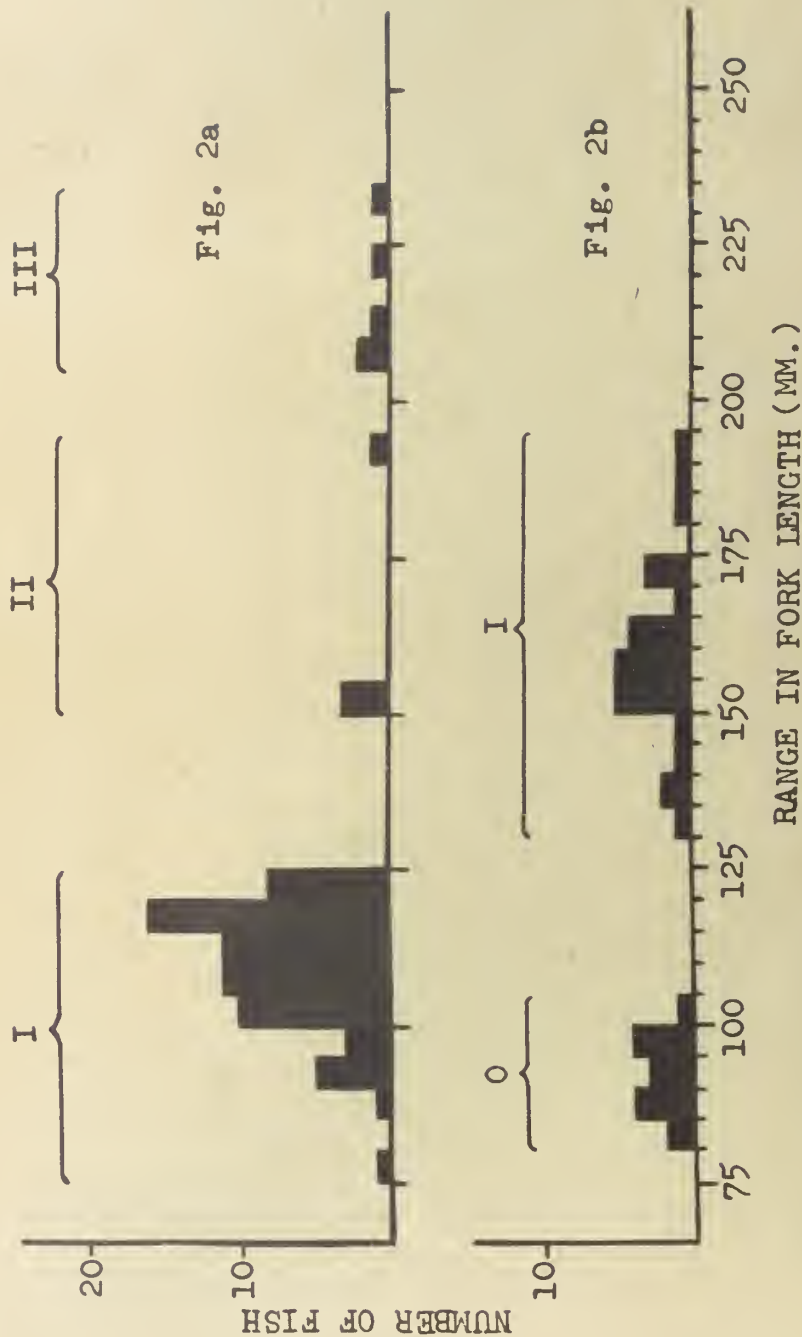


Figure 2 gives a comparison of the size frequency distribution of trout in the two sections of Vicary Creek. The upper panel (Fig. 2a) shows trout collected in June virtually at the beginning of an open season and the lower panel (Fig. 2b) shows trout collected in September of the same year. Both sections contained five pools and offered similar habitat for trout, therefore the sections may be expected to have similar trout populations. Examination of the two frequency distributions shows that they are quite different. Statistical comparison (Chi square test) also reveals that they are significantly different.

The age II and age III groups represented in the upper panel are missing in the lower and the age I fish which have become vulnerable to angling are noticeably reduced in number. Since the two sections were sampled during the same year the main cause of these changes can be ascribed to fishing.

Carbondale River

Fish population estimates were carried out in one section of the Carbondale River during this study. The section was sampled on September 5, 1956.

An attempt to sample the fish population during June of 1956 was unsuccessful as the high water made it difficult to keep seines in the stream. Further difficulty arose in obtaining effective concentrations of toxicant without endangering fish life for great distances below the study section. The June population estimates were therefore abandoned.

The section sampled in September consisted of 300 yards of stream in the vicinity of the junction of Lost Creek and Carbondale River. The calculated area of the section was 0.50 acres. Recovery of fish from the section was 109 cutthroat trout and 9 Dolly Varden with a total weight of 100 ounces. The standing crop of trout on September 5 was calculated to be 12.5 pounds per acre. Detailed analysis of the fish population of this section is presented in Table III.

Approximately two-thirds of the standing crop of trout in the study section of the Carbondale River consists of fish less than six inches in length. Only eleven trout over six inches and none over 9.9 inches (three years old or older) were present towards the end of the open season. Although a sample at the end of a closed season is not available

Fig. 3. Length frequency distribution of cutthroat trout in Carbondale River, September, 1956.

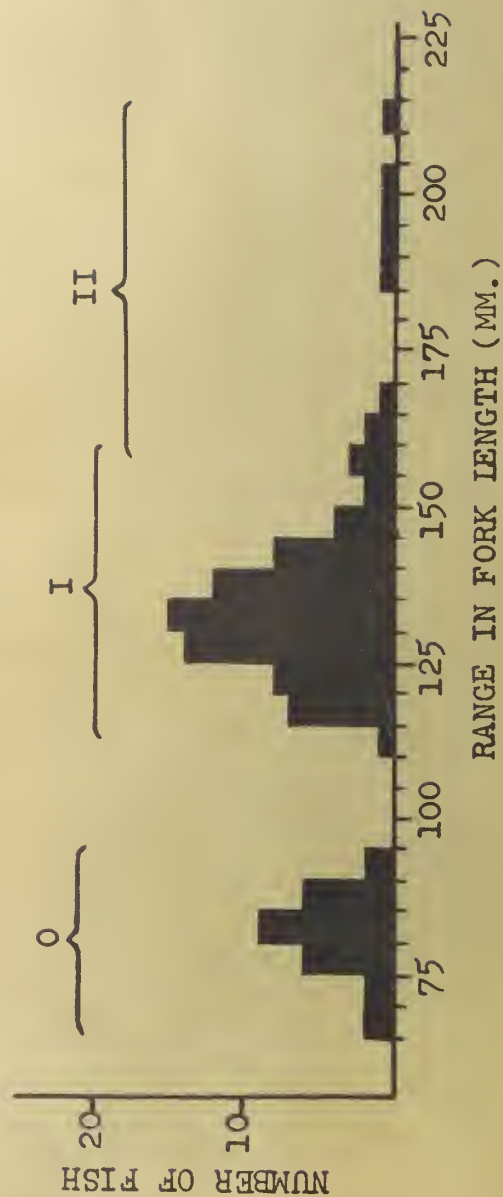


Table III. Fish populations in a section of the
Carbondale River on September 5, 1956.

Species and size range	Number Recovered	Total Wt. (lbs.)	Calculated pounds/acre	Calculated number /acre
Dolly Varden:				
Average 2.2 ins.	9	0.03	0.06	18
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	5	1.5	3.0	10
6.0 - 6.9 ins.	6	0.62	1.24	12
less than 6 ins.	<u>98</u>	<u>4.1</u>	<u>8.2</u>	<u>196</u>
Total:	118	6.25	12.50	236

for comparison, the data show a condition similar to that found in Vicary Creek and Daisy Creek.

Fig. 3 presents the frequency distribution of trout collected in the Carbondale River in September, 1956. Although no pre-fishing season sample is available for comparison the population structure is presented to show relative numbers and sizes of each year class present at the end of an open season. It is of interest to note the absence of age III

fish and the small numbers of age II fish. In this respect the population structure resembles that of other streams after a summer of fishing.

ANALYSIS OF SAMPLES FROM SULLIVAN CREEK, OPEN
ONE YEAR IN EVERY THREE (GROUP B).

Sullivan Creek

The fish population of Sullivan Creek was sampled in two sections of stream: Section I on September 10, 1955 and Section II on October 16, 1956. The 1955 samples represent fish populations affected by 2 years of stream closure followed by one open angling season. The 1956 samples are representative of a one year closure after the 1955 open season.

Section I.

Section I consisted of 360 yards of stream about one-third of a mile from the junction of the study stream and the Highwood River. The section contained a calculated area of 0.40 acres. Recovery of fish from Section I was 1254 trout, 44 longnose dace and 8 Rocky Mountain whitefish with a

total weight of 16.67 pounds. The standing crop of fish in the section of stream studied was calculated to be 41.7 pounds per acre.

Section II.

Section II consisted of a 300 yard long section of stream some 25 yards upstream from the upper limit of Section I. The area was 0.35 acres. Recovery of fish from the section was 962 trout, 14 Rocky Mountain whitefish and an undetermined number of longnose dace. Total weight of trout and Rocky Mountain whitefish was 39.10 pounds. The standing crop of trout and Rocky Mountain whitefish in Section II, therefore, amounts to 111.71 pounds per acre.

A further analysis of the fish populations in Section I and II is shown in Table IV.

Table IV shows that the standing crop of trout in October of a closed season (Section II) was 107.37 pounds per acre while in Section I in September of an open season the standing crop of trout was 38.68 pounds per acre. Of the total weight of trout per acre in Section II, 48.6 pounds per acre were accounted for by trout 6 inches or more in length.

Table IV. Fish populations in Section I, September 10, 1955, and Section II, October 16, 1956, of Sullivan Creek.

Species and size range	Number Recovered	Total Wt. (lbs.)	Calculated pounds/acre	Calculated number/acre
Section I, September, 1955.				
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	13	2.75	6.88	33
6.0 - 6.9 ins.	10	1.20	3.0	25
less than 6 ins.	1231	11.52	28.8	3078
Longnose dace	44	0.73	1.83	110
Rocky Mtn. Whites	8	0.47	1.18	20
Total:	1306	16.67	41.69	3266
Section II, October, 1956.				
Cutthroat:				
10 ins. or longer	3	1.52	4.34	9
7.0 - 9.9 ins.	48	11.05	31.57	137
6.0 - 6.9 ins.	33	4.44	12.69	94
less than 6 ins.	878	20.57	58.77	2508
Rocky Mtn. Whites	14	1.52	4.34	40
Total*	976	39.10	111.71	2788

*Undetermined number of longnose dace not included.

In Section I, the same length group account for 9.88 pounds per acre. No trout of the 10-inch or longer group were present in the latter section.

Fig. 4. Length frequency distribution of cutthroat trout in Sullivan Creek. Fig. 4a Sept., 1955; Fig. 4b Oct., 1956.

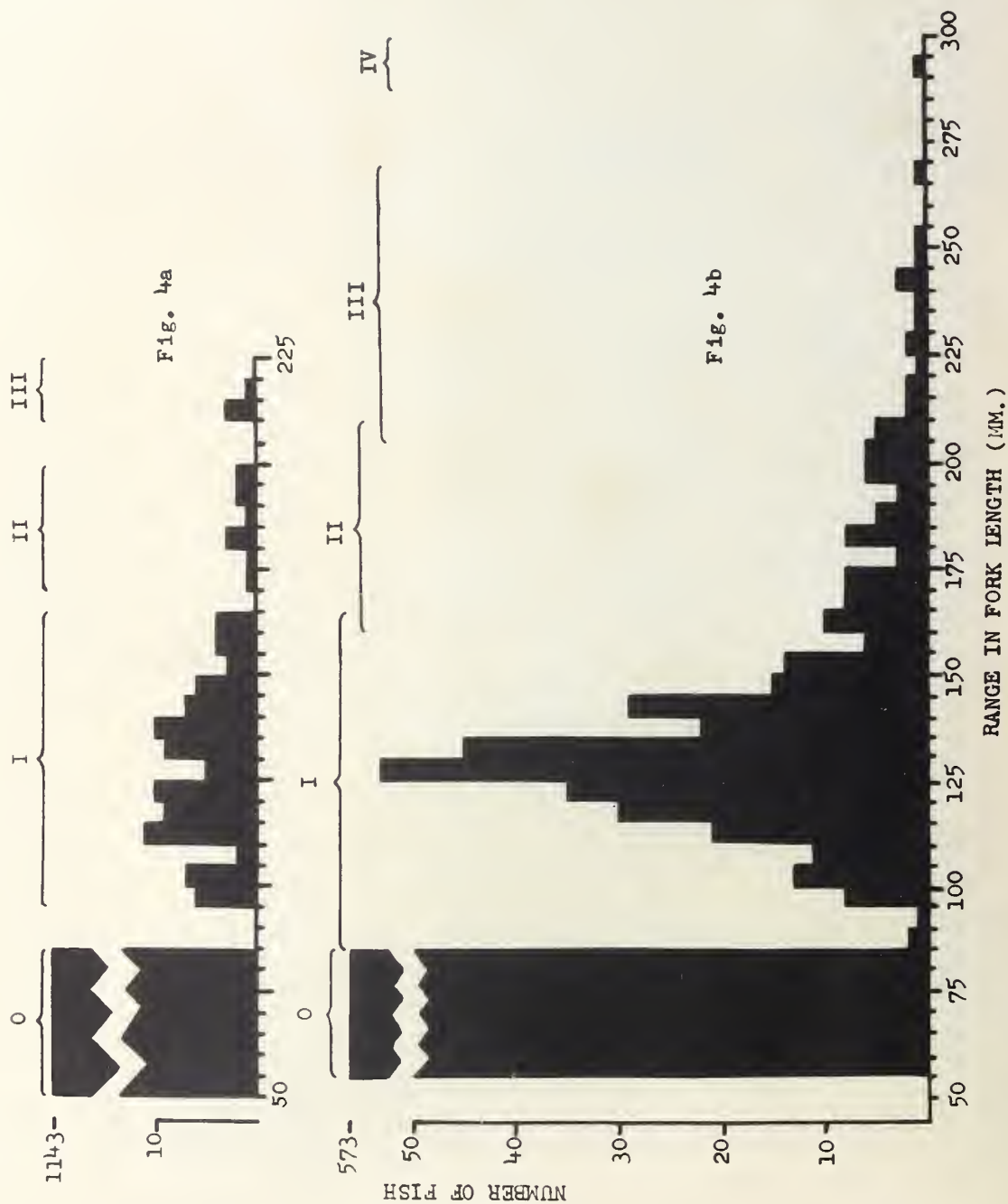


Figure 4 presents the size frequency distributions of trout from the two test sections of Sullivan Creek. Figure 4a shows trout collected from Section I in September, 1955 and Fig. 4b shows those collected from Section II, October, 1956. The sections were similar and therefore are assumed to be comparable from the standpoint of fish populations. A study of the two frequency distributions reveals that there is considerable difference in population structure. Chi-square analysis reveals that the populations are significantly different.

Our concern is mainly in the fish that are vulnerable to angling and with respect to these it is seen that in the fall of an open season there are no age IV fish; age III fish have been drastically reduced in number and those remaining are small. Age II fish are also represented by distinctly smaller numbers than in the fall of a closed season. Only the young fish are well represented in Fig. 4a. Sullivan Creek was open in 1955 and closed in 1956. The observed differences in the catchable sized fish, therefore, appear to be directly attributable to angling.

ANALYSIS OF STREAMS CHANGED FROM OPEN ONE YEAR
IN THREE TO OPEN ALTERNATE YEARS (GROUP C)

Bragg Creek

Sampling was carried out in two sections of Bragg Creek, Section I on June 25, 1955 and Section II on September 13, 1955. The stream was open to fishing in 1955 after one year of closure in 1954. Prior to 1955, this creek had operated on the two year closure - one year open plan but was changed to conform with the plan in effect on streams in the Oldman drainage.

Section I.

Section I comprised 300 yards of creek located several hundred yards above the junction of the study stream with the Elbow River. The calculated surface area of the section (June 25) was 0.43 acres. Recovery of fish from Section I was 189 cutthroat trout, 14 eastern brook trout, 2 Dolly Varden, 69 Rocky Mountain whitefish, 488 longnose dace and 3 white suckers with a total weight of 20.63 pounds. The calculated standing crop of fish in Section I on June 25, 1955 was 48.0 pounds per acre.

Section II.

Section II consisted of 250 yards of stream with a calculated surface area of 0.31 acres. It was located approximately 35 yards upstream from the upper limits of Section I. Recovery of fish from the section was as follows: 42⁴ cutthroat trout, 33 eastern brook trout, 35 Rocky Mountain whitefish, 4 white suckers and an undetermined number of longnose dace. Total weight of fish, excluding dace, was 5.81 pounds. The standing crop of fish in Section II on September 13, 1955 was calculated to be 18.7⁴ pounds per acre. Detailed analysis of the fish population of Sections I and II is shown in Table V.

Table V shows that of a total standing crop of fish in Section I, 40 percent or 19.2⁴ pounds per acre was contributed by trout. Trout 6 inches or longer contributed 5.82 pounds per acre. Section II had a standing crop of 15.52 pounds per acre of trout. Approximately one-fifth of the latter figure, or 3.13 pounds per acre, was contributed by trout of the 6 inch or longer group. Size frequency distribution of trout from the two sections is presented in Figure 5.

Table V. Fish populations in Section I, June 25, 1955, and Section II, September 13, 1955, of Bragg Creek.

Species and size range	Number Recovered	Total Wt. (lbs.)	Calculated pounds/acre	Calculated number/acre
Section I, June, 1955.				
★Trout:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	5	1.19	2.77	12
6.0 - 6.9 ins.	11	1.31	3.05	26
less than 6 ins.	187	5.77	13.42	435
Dolly Varden	2	0.42	0.98	5
Rocky Mtn. whites	69	3.0	6.98	160
Longnose dace	488	8.34	19.39	1135
Suckers	<u>3</u>	<u>0.60</u>	<u>1.40</u>	<u>7</u>
Total:	765	20.63	47.99	1780
Section II, September, 1955.				
★Trout:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	2	0.50	1.61	6
6.0 - 6.9 ins.	4	0.47	1.52	13
less than 6 ins.	451	3.84	12.39	1455
Rocky Mtn. whites	35	0.25	0.80	113
Suckers	<u>4</u>	<u>0.75</u>	<u>2.42</u>	<u>13</u>
Total:	496	5.81	18.74	1600

★'Trout' refers to cutthroat and eastern brook combined.

Fig. 5. Length frequency distribution of cutthroat trout in Bragg Creek. Fig. 5a June, 1955; Fig. 5b September, 1955.

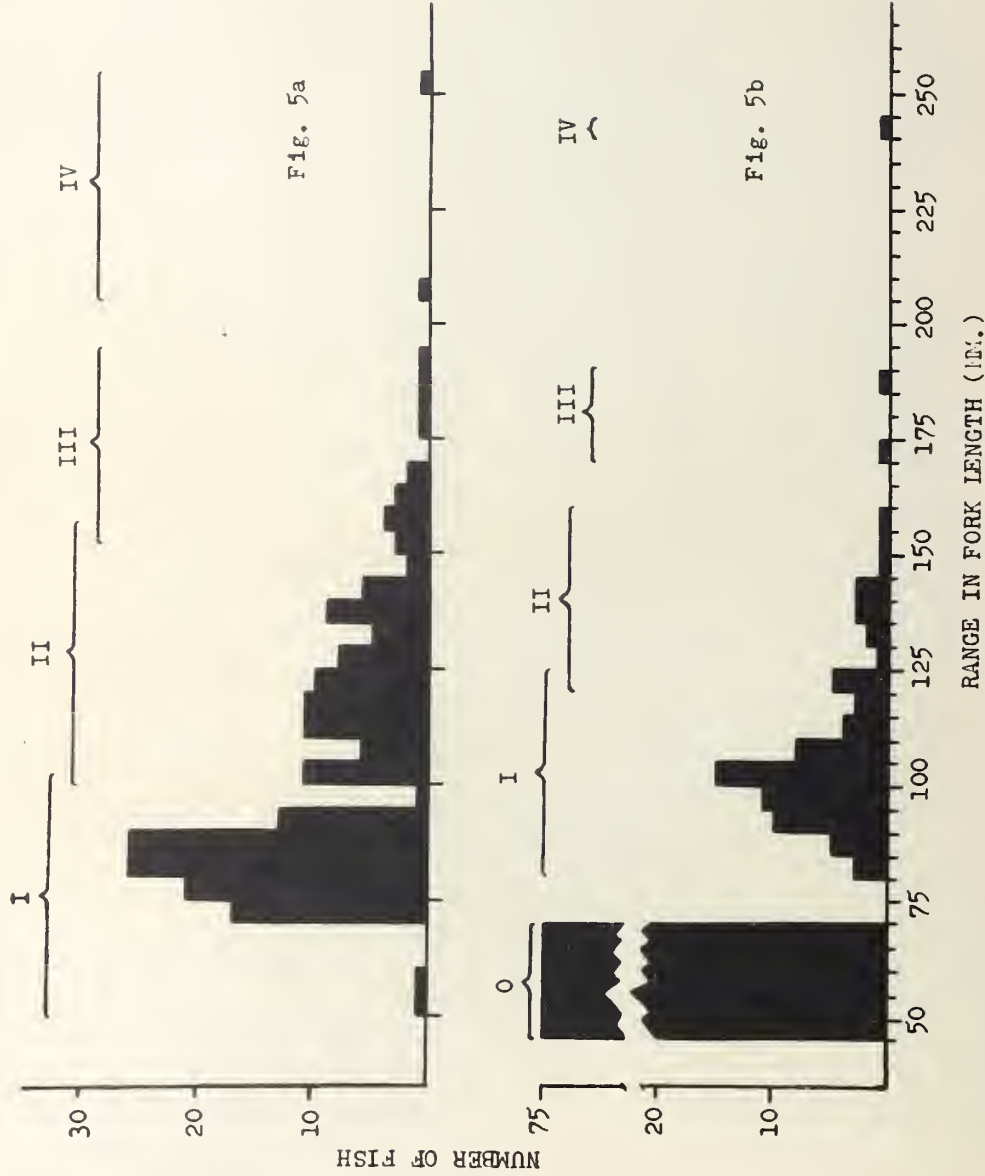


Figure 5a shows the trout collected from Section I in June, 1955, and figure 5b shows those collected from Section II in September, 1955. From the standpoint of stream size, number of pools, and cover conditions the two sections are comparable. A study of the two frequency distributions shows that the population structures of the two sections are different. Statistical comparison (Chi-square test) of the two frequency distributions shows them to be significantly different.

In Fig. 5a it is apparent that most of the age III fish and the larger age II fish have been removed from the population. The large age I fish also appear to have been affected. Since these frequency distributions represent populations in similar sections during the same year the observed differences can be attributed mainly to the effect of angling.

North Fork Sheep

Sampling of the fish population of North Fork Sheep was carried out in two sections of the stream during successive years. Section I was sampled

on June 22, 1955, and Section II on July 24, 1956. Section I is representative of the stream after two years of closure and one year of open season. Section II is representative of the stream during an open fishing season following one year of closure.

Section I.

Section I consisted of 250 yards of stream located above the confluence of the study stream and Ware Creek. The calculated area of the section was 0.46 acres (June, 1955). Recovery of fish from the section was: 62 cutthroat trout, 2 Rocky Mountain whitefish, 15 longnose dace and 1 white sucker. The combined weight of all fish was 32.3 ounces, giving a calculated standing crop of 4.4 pounds per acre in Section I.

Section II.

Section II consisted of 300 yards of stream located approximately two water miles upstream from Section I. The calculated area of the section was 0.56 acres. Recovery of fish from the section was: 137 cutthroat trout, two Rocky Mountain whitefish , five ^{Jordans} suckers and 314 longnose dace. Total weight of

all fish was 178 ounces. The calculated standing crop of fish in Section II was 20.5 pounds per acre. Detailed analysis of the fish population of Sections I and II is presented in Table VI.

It was found that Section I was supporting a total standing population of 4.42 pounds of fish per acre of which approximately 68 percent was trout. Section II was found to be supporting a total of 20.54 pounds of fish per acre of which 44 percent or 9.11 lbs. per acre consisted of trout. It is further evident that Section II contained twice as many trout over 6 inches in length as Section I. Section II had been subjected to relatively heavy fishing pressure for at least six weeks prior to sampling and undoubtedly a considerable number of catchable sized trout had been removed. Thus the discrepancy in standing crops of the two sections would have been greater had sampling been carried out in Section II at the beginning of the 1956 fishing season.

A comparison of the size frequency distribution of the two sections is shown in Fig. 6. A marked effect of a year's fishing on Section I is revealed.

Fig. 6. Length frequency distribution of cutthroat trout in North Fork Sheep. Fig. 6a Section I, June, 1955; Fig. 6b Section II, July, 1956.

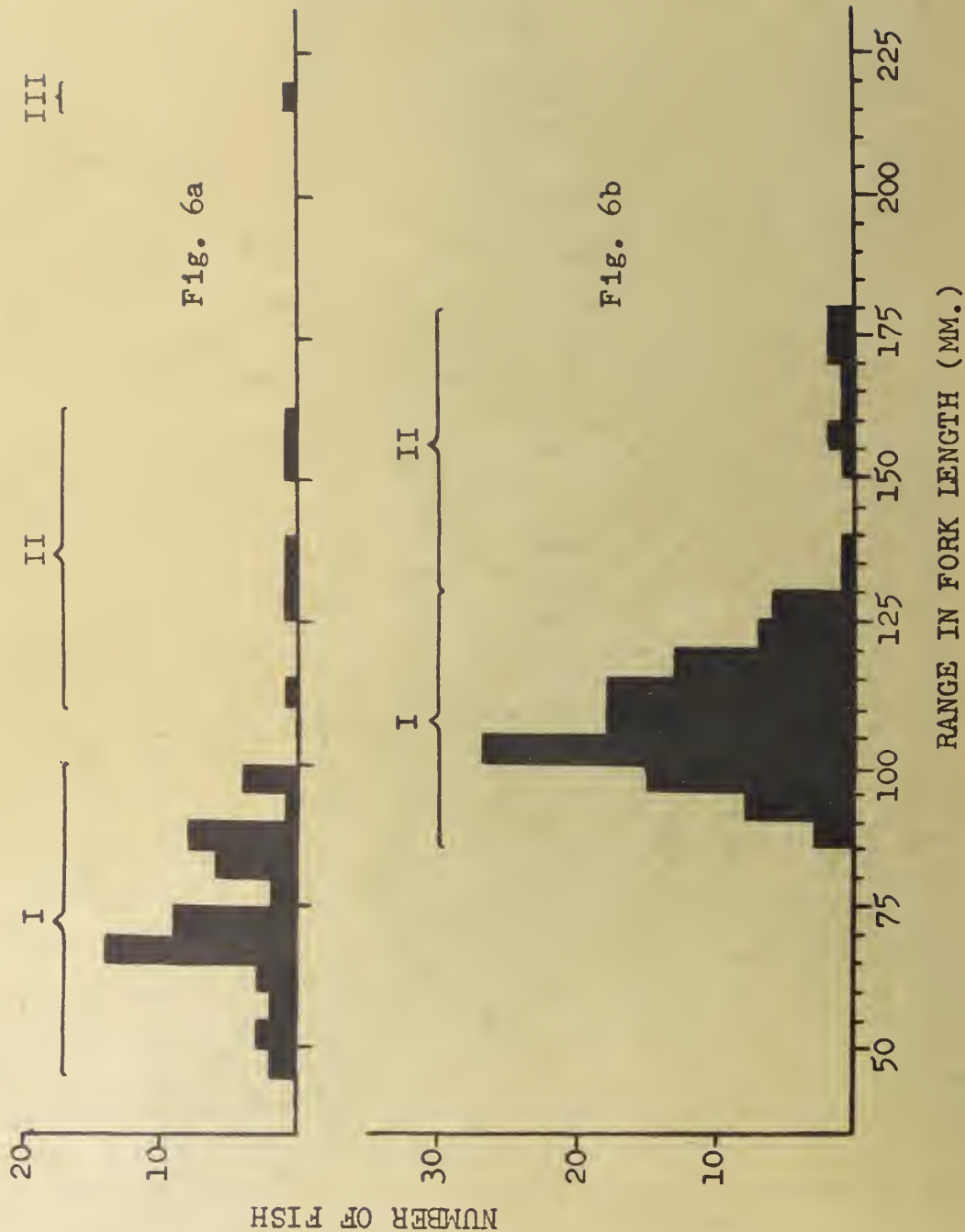


Table VI. Fish populations in Section I, June 22, 1955 and Section II, July 24, 1956 in North Fork Sheep.

Species and size range	Number Recovered	Total Wt. (lbs.)	Calculated pounds/acre	Calculated number/acre
Section I, June, 1955 (Following open season).				
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	1	0.34	0.74	2
6.0 - 6.9 ins.	3	0.45	0.98	6
less than 6 ins.	58	0.60	1.30	126
Rocky Mtn. whites	2	0.09	0.19	4
Longnose dace	15	0.25	0.54	33
White suckers	<u>1</u>	<u>0.31</u>	<u>0.67</u>	<u>2</u>
Total:	80	2.04	4.42	173
Section II, July, 1956 (Following closed season).				
Cutthroat:				
10 ins. or longer	-	-	-	-
7.0 - 9.9 ins.	2	0.28	0.50	3
6.0 - 6.9 ins.	7	0.78	1.40	13
less than 6 ins.	122	4.04	7.21	218
Rocky Mtn. whites	2	0.75	1.34	3
Longnose dace	314	5.37	9.59	561
Suckers (Jordan's)	<u>5</u>	<u>0.28</u>	<u>0.50</u>	<u>9</u>
Total:	452	11.50	20.54	807

COMPARISON OF THE YIELDS OF DIFFERENT TEST STREAMS

In order to facilitate comparison of the total weight of trout recovered from test sections of the six study streams Table VII has been prepared.

Table VII. Standing population of trout in test sections of six East Slope trout streams.

Stream	Year	Area of test sections (ac.)	Total wt. lbs./ac.	Closed during preceding summer
Daisy Creek	Sept. 1955	0.43	15.19	Yes
	Sept. 1956	0.36	10.72	No
Vicary Creek	June 1956	0.37	10.20	Yes
	Sept. 1956	0.37	7.70	No
Carbondale River	Sept. 1956	0.50	12.5	No
Sullivan Creek	Sept. 1955	0.40	38.68	No
	Sept. 1956	0.35	107.37	Yes
North Sheep	June 1955	0.46	3.02	No
	July 1956	0.56	9.11	Yes
Bragg Creek	June 1955	0.43	19.24	Yes
	Sept. 1955	0.31	15.52	No
Grand Average of all sections:			22.66	

It may be noted that in every case the standing crop of trout is substantially larger after a summer of no fishing.

Shetter and Leonard (1943) report a standing population of 94.40 pounds per acre of brook trout in a section of Hunt Creek, Michigan. Stefanich (1952) gives the weight of trout as varying from 43.78 to 67.91 pounds per acre over a two year period in Prickley Pear Creek, Montana. Smith et al. (1949) report an average of 40.19 pounds per acre of trout in sections of 18 streams in the Root River system and 11.4 pounds per acre in test sections of 4 streams in the Whitewater system in Minnesota. Schuck (1945) gave the average weight of brown trout in Crystal Creek, New York as 13.85 pounds per acre, over a four year period. The average of 22.06 pounds per acre for six Alberta streams is somewhat better than the average for a few Minnesota and New York streams but is considerably less than the average for some 20 other streams reported on.

GROWTH RATES AND AGES AT MATURITY OF TROUT IN THE TEST STREAMS

Since measurements were taken from trout collected in each stream and scales were studied to determine ages, a comparison of the growth rates of

trout in the different streams may be made. These data are presented in Table VIII.

Table VIII. Growth rate of trout from six East Slope streams.

Name of Stream	Time of Collection	Av. fork length (ins.) at each age				
		0	I	II	III	IV
Daisy Creek	September	2.1	5.2	8.3	11.1	-
Vicary Creek	September	3.5	6.2	-	-	-
Carbondale R.	September	3.3	5.2	7.2	-	-
North Sheep	July	-	4.2	6.1	-	-
Sullivan Creek	September	2.8	5.2	7.4	9.4	11.5 [★]
Bragg Creek	September	2.3	4.1	5.8	6.5	9.0

★One fish only.

The data relating to age and growth of trout from six East Slope streams show that the Bragg Creek trout grow more slowly than trout from the other study streams. Four summers' growth are required to produce fish of catchable size in Bragg Creek, whereas in other streams examined this growth is exceeded by the end of the third summer. Vicary Creek trout show the

best growth of the ^{six} ♂ groups during the first two summers of life. Growth at the age 0 group (spawned the previous spring) is known to be somewhat variable from year to year, depending on stream conditions during the spawning season.

Although the size of trout kept by anglers varies with the individual fisherman, it may be generally stated that in at least five of the test streams, trout become vulnerable sometime during their third summer. The population structures obtained from sampling during an open season further indicate that the faster growing members of the age I group are also retained by anglers.

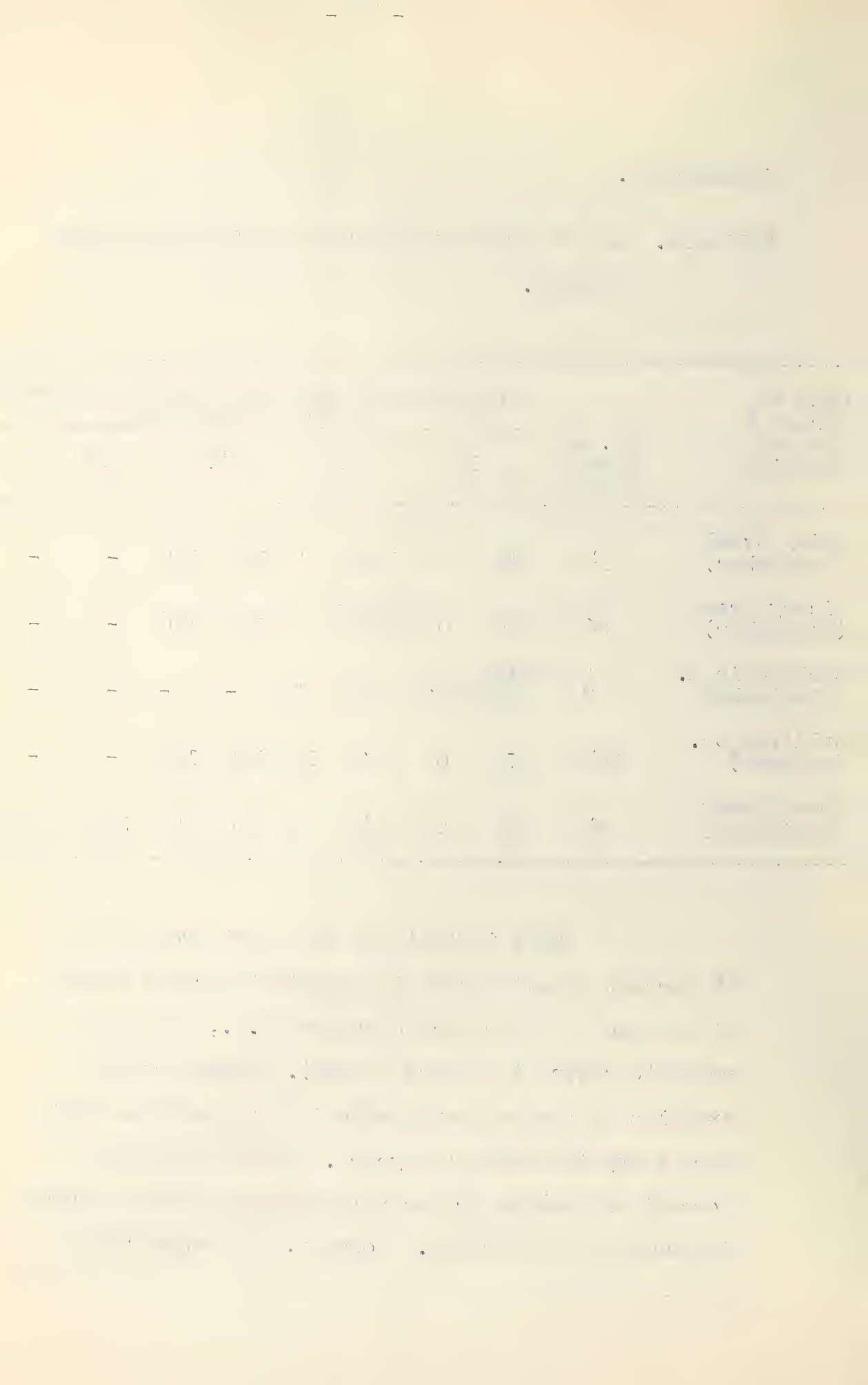
In streams where natural reproduction is relied on to sustain a satisfactory trout population, the age at which the trout become sexually mature is an important consideration in the management plan. Thus if female trout mature at three years of age and most of them are removed by the fishery by the end of the second summer, such a fishery could deplete the adult stock to the point where insufficient numbers are present to adequately stock the stream with young trout. The possibility of such a condition arising out of a fairly heavy fishing pressure was considered during this investigation. The conditions of the gonads were checked in samples from each age class except in the age 0 group, in most of the test streams. The findings are summarized

in Table IX.

Table IX. Age of trout at maturity in five East Slope streams.

Name of stream & time of sampling	No. of trout examined	Percentage of male and female specimens mature at each age							
		I		II		III		IV	
		♂	♀	♂	♀	♂	♀	♂	♀
Daisy Creek (September)	34	85	0	100	9	100	100	-	-
Vicary Creek (September)	26	60	No specimens		0	100	100	-	-
Carbondale R. (September)	7	None Examined		50	17	-	-	-	-
Sullivan Cr. (October)	104	81	0	92	19	100	100	-	-
Bragg Creek (September)	54	50	0	64	0	100	75	100	No specimens

Data in Table IX show that from 50 to 85 percent of male trout in four test streams mature at the end of their second summer (i.e., they are ready to spawn at 2 years of age). There are no examples of female trout taken in test sections that were ready to spawn at 2 years. Nine to nineteen percent of females are sexually mature at three years in three of the streams. However, the table shows



that none of the females is mature at 3 years in Vicary and Bragg Creeks. This may be due in part to the small numbers of female trout of this age group available for examination. Of the streams from which age IV samples were available, Bragg Creek is the only exception to all fish of both sexes being mature at four years. The number of fish examined from the Carbondale River is too small to establish accurately the age of maturity except to suggest that a certain percentage of both sexes are mature at 3 years of age. If it is assumed that the population structures in the test sections are representative of the more accessible and heavily fished portions of the respective streams, there is reason to believe that removal of mature female trout is excessive during an open season in these areas. Thus Section II of Daisy Creek contained no female trout that would spawn in the spring of 1957 and Section I contained only three females that would spawn in 1956, providing all three survived the winter. Section II of Vicary Creek contained no mature female trout. Section I of the Carbondale River contained one mature female. At the end of a closed season, Section II of Sullivan Creek yielded five mature female trout but Section I (end of open season) contained no

mature females. Bragg Creek results were similar in that Section I (June, following closed season) contained three mature females while Section II (fall of open season) contained none.

The test areas of Daisy Creek, Vicary Creek and Carbondale River yielded few trout-of-the-year in fall samples and although as previously stated, recovery of the age 0 fish was not complete, the author's opinion is that actual numbers of these trout were considerably less than are present in more lightly fished areas of the streams.

The Sullivan Creek data present a problem for which no satisfactory explanation has been found. No mature female trout were recovered in Section I (1955) but 558 age 0 trout were present in Section II the following year. Two theories as to the cause of this situation might be advanced:

(a) There were mature female trout present in Section II though apparently none in Section I at the time of the 1955 sampling.

(b) Some female trout from the Highwood River ascended lower Sullivan Creek to spawn.

Further investigation into weak year classes resulting from excessive removal of female breeding stock should be conducted before definite conclusions can be made.

ROCKY MOUNTAIN WHITEFISH IN TEST STREAMS

Little is known of the behaviour of this species in the smaller tributary streams on the East Slope. These fish are known to be resident in most of the larger streams throughout the entire year and many are caught by anglers in pursuit of trout. Some of the smaller tributaries, however, do have resident populations while others do not. These fish appear to be seasonal visitors to the lower reaches of some streams in which they have not become established as a breeding population. The following observations were made during this study.

Daisy Creek - Rocky Mountain whitefish present in lower reaches of the creek in June, 1955. Non² recovered in Section I, September, 1955 or in Section II, September, 1956.

Vicary Creek - Fourteen Rocky Mountain whitefish recovered from Section I, June, 1956. None recovered in Section II, September, 1956.

Carbondale River - None recovered in a section September, 1956. Eleven taken near the mouth of this stream, September 8, 1955.

North Fork Sheep - Section I, June, 1955, two immature specimens taken. Section II, July, 1956, two adult specimens recovered.

Sullivan Creek - Section I, September, 1955, eight immature specimens recovered. Section II, October, 1956, 14 immature specimens recovered.

Bragg Creek - Section I, June, 1955, 69 specimens ranging from age I to mature adults. Section II, 35 specimens ranging from age 0 to mature adults. August, 1956, both immature and mature specimens taken by angling some 5 miles upstream from mouth of creek.

From the foregoing it may be concluded that Rocky Mountain whitefish are resident in Bragg Creek and North Fork Sheep and are known, from observation, to provide some angling in these streams. In the remainder of the test streams they are of little importance as game fish since they do not appear to be present as breeding populations.

It is of interest to note that occurrence of Rocky Mountain whitefish in Daisy and Vicary Creeks was recorded in June but not in September. This appears to be contrary to the opinions of some anglers that these fish move into the tributaries in the fall to spawn.

CONCLUSIONS

1. With a few exceptions, such as Sullivan Creek, trout production in these streams must be considered to be rather low.
2. Present angling pressure during an open season is sufficient to cause removal of most of the trout over two years of age and hence make serious inroads into the brood stock. Lengthy open seasons each year could be expected to remove fish almost as rapidly as they become vulnerable to angling.
3. At least one year of closure to angling is required to assure a minimum of natural reproduction. The results obtained from Vicary Creek and North Fork Sheep would appear to justify a two year closure on some streams.
4. In order for the one year fallow system to operate with efficiency, a rigid enforcement of the closure period will be necessary.

SUMMARY

1. Fish population studies were carried out in limited sections of three streams under the alternate open and closure management plan, in one stream under the open one-year-in-every-three plan and in two streams which had been previously open one year in three but were changed to alternate open and closure at the beginning of this investigation.

2. Sampling was carried out in the fall of a closed season and again in the fall of an open season in Daisy Creek and Sullivan Creek. In Vicary and Bragg Creeks sampling was done in June and September during the open season. The Carbondale River was sampled once in the fall of an open season.

3. On all streams tested, the population structure was shown to change significantly after a season of fishing and this change was attributed primarily to removal of fish by angling. In all cases the standing population of trout, in terms of pounds per acre, also decreased after an open season.

4. The standing ^{crop}~~population~~ of trout in the fall of an open season varied from a low of 7.7 pounds per acre in Vicary Creek to 38.68 pounds per acre in Sullivan Creek. The average standing ^{crop}~~population~~ of

trout in sections of five East Slope streams in September during an open year, was 17.02 pounds per acre. The grand average for all test sections (during both open and closed years) was 22.66 pounds per acre. This is considerably lower than most of the trout populations reported by U.S. workers.

5. The fish populations in the test sections show that in readily accessible streams, either a very low number or no mature females are left to reproduce by the end of an open season. In the entire study, only 4 fish reached the age of 4 years and none was recorded past this age. Age-at-maturity studies show that less than twenty percent of the female trout examined were mature by the end of the third year of life. Most of the females are removed before they have spawned once and virtually none live to spawn more than once.

6. Rocky Mountain whitefish are of relatively no importance in most of the small East Slope tributaries. In the exceptions to this rule e.g., Bragg Creek, they may contribute a significant portion to the fish catch.

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